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MARKETING OF ENERGY CONSERVATION SERVICES TO HOMEOWNERS: A DIRECT RESPONSE APPROACH*

Manohar U. Kalwani, Christopher K. McLeod,
and Steven J. Miller**

WP 1078-79 August 1979

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Marketing of Energy Conservation Services to Homeowners: A Direct Response Approach

This paper examines the use of a direct response approach for the marketing of energy conservation services, and in particular, for the generation of sales of home energy audits. The response rates (proportion of audit sales) that were realized in mailings to the general population were as cost-effective as a personal selling approach for these services. Economic analysis reveals that the response rates of about 1% obtained from direct mailing of brochures are well worth the money for a full-service energy firm. Joint efforts with special interest groups are important in communicating trust to member constituents of these organizations, a quality that is sorely missing in the energy conservation business.

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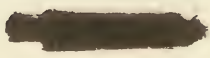

The Residential Market for Energy Conservation Services

Experts in the energy field expect the supply of energy to fall short of demand for the next decade or more (Stobaugh and Yergin 1979). None of the major energy options--imported and domestic oil, natural gas, coal, synthetic fuels, nuclear and solar power--are likely to be copiously available, and in some cases considerable effort will be required just to sustain current supply levels. Stobaugh and Yergin assert that conservation is the only way out of the present crisis. "Conservation may be the cheapest, safest, most productive energy alternative readily available in large amounts. It does not threaten to undermine the international monetary system, nor does it emit carbon dioxide into the atmosphere, nor does it generate problems comparable to nuclear waste," (Stobaugh and Yergin 1979).

When President Carter declared the energy crisis the "moral equivalent of war," he stated that "conservation is the cornerstone of our policy" (Yergin 1979). This directive and the Federal Government's active promotion of energy conservation (e.g., 15-second television spots using feature celebrities) led to many predictions that conservation firms serving the residential market would "take off" and soon realize handsome profits. However, the performance of this industry has failed to match its expectations (Department of Energy 1978), as American homeowners continue to be slow in utilizing conservation services.

Several reasons have been cited for this resistance. A basic problem is that conservation is counter to the predominant trend of inefficient energy-use habits over the past several decades when little attention was paid to prevent its waste. In addition, many people do not believe there is an "energy crisis" (although this view faces stronger and stronger challenges). "The reality of an energy shortage is <u>not</u> a given for about half the people

in this country" (Milstein 1977, p. 5). Milstein adds: "About one-third of the public is quite skeptical about any energy shortage, and thinks it is a contrivance for economic or political gain by vested interests" (p. 5).[1] A Gallup survey conducted for the Federal Energy Administration in March of 1977 revealed that people who think the energy shortage is real also tend to be more concerned about such shortages and tend to practice certain conservation behaviors (Milstein 1977, p. 4).

The greatest need for energy conservation services is in existing houses. "Retrofitting" (as it is called) is more difficult and expensive than incorporating energy conservation measures into new construction. A homeowner faces average costs of about $2,000 to retrofit a house, which is a major purchase expense. "Most significantly, the key barrier to the development of improved energy efficiency in residential home construction is seen by the builders as first cost" (Department of Energy 1976, p. IV-2).

The folklore and general image of energy conservation firms has also not been favorable: firms are stereotyped as being staffed and run by moonlighters who have other full-time commitments, or who lack essential knowledge or experience and have taken up this work as a stopgap.

Finally, the industry itself has not developed effective marketing strategies and tactics, but appears to have largely relied on the inevitability of higher energy prices or tighter supplies to bring customers to them. A recent article in The Wall Street Journal ("Consumers Pass Up Home Energy Audits Despite Potential Savings if Waste is Cut", August 30, 1979, p.7) points out that despite escalating fuel costs, many homeowners are passing up audits which in many cases are free. Conservation is a good deal with possible energy savings in each household of as much as 30 to 40%; the primary problem, it explains, "is a marketing one". It is not entirely surprising, then, that

energy conservation firms have had a difficult time establishing and developing a profitable business.

The Energy Bank and Its Initial Marketing Strategy

This paper describes marketing research that was done with a small energy conservation firm, The Energy Bank, toward developing an effective program for marketing the services of the company to homeowners in the Boston, Massachusetts area. Full-service firms are a relatively new type of enterprise in the energy conservation field. They provide potential customers with the convenience of working with a single company in meeting a range of needs, and the security of contracting with a company that offers a more professional and reliable service than a "fly-by-night" operator can.

Like many full-service firms, The Energy Bank performs two basic services for homeowners: a complete home energy audit, and an installation service. The energy audit provides detailed information on alternative energy conservation investments and identifies the one(s) with the greatest economic returns (in terms of the shortest payback period). A nominal fee of $25 is charged for the audit to cover out-of-pocket expenses.

One week after the homeowner receives the audit report, he or she is contacted by telephone by The Energy Bank to see if there is interest in having any of the suggested retrofit work done. A total of two-thirds of the homeowners who have audits performed are converted into actual retrofit sales.

The high conversion ratio led The Energy Bank to seek ways to increase the sale of energy audits. Limited financial resources restricted the use of an in-house sales force. Media advertising appeared to be too expensive and ineffective. The principal marketing approaches that were being used were telephone directory (Yellow Pages) advertising, the reliance on contacts

made at presentations by company officers at community meetings, and clients obtained from word-of-mouth sources.

The Energy Bank had also initiated a new approach to selling its services at the time this research began. The firm had been approached by Massachusetts Fair Share (MFS), a consumer-interest group that was seeking to broaden its portfolio of services, to sell energy conservation services to MFS members and the general public. MFS offered The Energy Bank a ready-made direct sales force in its well-trained community canvassers. MFS also provides a base of potential customers (its members), and the endorsement of a consumer-interest group with state-wide reputation, which is important in communicating trust to homeowners.

For its part, MFS receives a direct consumer service to add to its other political, legal, and social activities for members. The marginal cost to MFS for marketing the energy audit is small when this effort is combined with membership solicitation, and the effort can easily be made self-supporting through retrofit sales. This diversifies the financial base of MFS, another goal MFS was seeking.

In short, the relationship appears to be promising and beneficial for both organizations. Both organizations also agreed to participate in the research that is reported in this paper, since both would gain from the development of a more effective marketing plan.

Research Design and Activities

Formulation of a marketing strategy for a product or service requires knowledge of the target market, selection of a communication medium, and development of a core selling proposition. This section describes the activities that were undertaken regarding each of these topics, and the overall plan that tied these efforts together.

The general approach that was used in this research was direct response marketing. Direct response marketing is a process whereby a product or service is sold directly to the final customer without the use of intermediaries. Direct mail marketing is the most common, though not the only, direct response marketing method in use today (Stone 1975).

For The Energy Bank and MFS, a central question that was addressed by this research was whether a direct response marketing program could be an effective marketing tool for the energy audits; i.e., was it as cost-effective as other approaches, like personal selling? Selling retrofit services clearly required personal selling effort, but should the energy audit sales be done differently?

The first step in the research was to develop additional knowledge about the target market for the service. Once the key characteristics of the target market were known, a test could be made of the effectiveness of a direct response campaign (step 2), and experiments conducted on the appropriate core selling proposition (step 3). Each of these activities is described separately below.

Developing a Customer Profile

One ready source of information concerning the target market is the existing customer base. The characteristics of past buyers--demographic and psychographic--are likely to provide important clues to identifying the most likely future buyers of a product or service.

To gather this information, a telephone survey of thirty purchasers of The Energy Bank's audit was conducted. The respondents were randomly selected from three hundred recent audit purchasers. Twenty-seven responses were usable and are reported in Table 1. Homeowners who purchased only the audit are differentiated from those who also had retrofit services performed.

Table 1 shows that people who had their homes retrofitted were wealthier (both in terms of income and property value), lived in older homes, had lived there longer, and were more likely to have a college education than those who purchased only the energy audit.

INSERT TABLE 1

As significant as these differences between the groups may be, the differences between the retrofit customers and the general population are even more substantial.

The 1970 Census (as adjusted for 1978[2]) reports that the median property value in the Boston SMSA is about $50,000, and the median family income (as adjusted) is $14,400. From the telephone survey, however, 94 percent of the respondents who used the retrofit service owned property of at least $50,000 value, and 88 percent of these retrofit customers had family incomes of $14,400 or more. Assuming that family income and property value are highly correlated, the message is very clear: The Energy Bank's customers are wealthier than the general population.

The "age of structure" was also examined for The Energy Bank's customers. As expected, the homes tended to be older, since newer homes have been built with more emphasis on energy conservation than older ones.

The telephone survey provided other interesting information. Over 70 percent of those who had their homes audited by The Energy Bank perceive an "energy crisis" within the United States today, and a full 85 percent believe there will be a crisis situation within the next five years. Comparable figures for the U.S. population are difficult to obtain, but as mentioned earlier, public opinion polls suggest that only 50 percent of the general population believe that the energy situation is in a crisis state (Milstein 1977, p. 5, and Department of Energy 1978, p. 24).

The respondents were also asked to indicate the most important reasons for having their homes audited. Three reasons were commonly cited: cost savings; the desire to increase comfort; and, the fact that they were already performing home repairs and wanted to take advantage of this opportunity to make conservation improvements.

To summarize, The Energy Bank's "typical" customer has a family income around $20,000, lives in an older home valued in the $50-75,000 range, is college educated, perceives an energy crisis, and is motivated to use a residential energy conservation service both for its potential cost savings and anticipated improvement in comfort.

It is worth mentioning that the profile of a buyer of The Energy Bank's services, developed here, is consistent with the description of the people practicing energy conservation behavior reported in Milstein (1977). These people perceive that the "energy shortage is real" and tend to be "higher income, suburban people in professional and managerial occupations." (p. 4).

Evaluating a Direct Response Campaign

The next step of the research was a controlled experiment to verify the definition of the target market, and to compare the cost-effectiveness of a direct mail approach to one that used personal selling. The experiment was carried out in the Fall of 1978; its design is displayed in Table 2. Both MFS members as well as non-members were included in the sample.

INSERT TABLE 2

Homeowners who were not MFS members were sent a brochure, following the research design in Table 2, by mail or in person (along with a five minute

sales pitch) in two Boston suburbs, Newton and Melrose. Newton is an upper-middle income suburb of Boston that has a median family income of $25,738 (see Footnote 1). It was chosen as a community possessing characteristics of the target market. Both the Energy Bank and MFS were interested in investigating the economics of extending similar direct marketing efforts to less affluent communities, so Melrose, another Boston suburb with a median family income of $19,600, was chosen towards this end. Melrose was selected because its "type of structure" and "age of structure" distributions were identical to those of Newton (McLeod and Miller 1979). This, it was felt, would permit verification of the target market definition since Newton was expected to yield a significantly higher proportion of audit sales than Melrose.

A two-stage sampling procedure was used to select homeowners in Newton and Melrose. First, census tracts (two in Newton and one in Melrose) were selected in each suburb that were representative of the total population of the individual suburbs on family income and property value. Next, in each tract a group of five to six blocks were chosen to receive a brochure in person. A random selection of households to receive a personal sales presentation was not done to minimize word-of-mouth effects due to interaction between neighbors receiving different treatments. A random sample of approximately 750 of the remaining homeowners in each tract were sent a brochure in the mail.

To compare the proportion of audit sales generated by mail with that obtained from personal selling approach the criterion was adopted of detecting a 1 percent difference in response rates with a 95 percent confidence level. Since direct mail response rates generally vary between 1/2 and 1 1/2 percent, the required sample size for this determination was 760.[3] Both time and cost considerations dictated that a limited number of people (around 250) would be approached in the personal selling campaign.

In addition, as indicated in Table 2, brochures were mailed to 250 MFS members each in Newton and Melrose. These respondents were selected randomly from MFS membership lists in these two cities. It was expected that MFS member mailings would yield higher response rates than non-member mailings.

The core selling proposition in the brochure was that energy conservation can save the homeowner money. A secondary element of the brochure was MFS's endorsement of The Energy Bank's expertise and service. As a non-profit consumer advocate, MFS's endorsement, it was reasoned, would be valuable in allaying the consumers' stereotypical fears of the home construction/retrofit industry. Finally, additional attempts were made to demonstrate The Energy Bank's technical expertise in this field.

The personal sales presentation was a five-minute pitch on the home energy audit. The homeowner was given a brochure and asked to call The Energy Bank for an audit. No orders were taken on the spot. Further, no attempt was made to sell MFS membership.

Results of the Fall experiment are reported below, following the description of the second experiment.

Defining a Core Selling Proposition

The second controlled experiment was carried out in the Spring of 1979; its design is also shown in Table 2. The findings of the Fall study supported the initial target market definition--a wealthier homeowner living in an older home--so the next step, development of a core selling proposition, was undertaken. In the Spring campaign, homeowners in two Boston-area communities with characteristics of the target group (Arlington and Belmont) were chosen to receive alternative brochures.

The brochure that emphasized cost savings was similar to the brochure used in the Fall experiment. A second brochure was designed to present comfort

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The brochure that emphasized cost savings was similar to the brochure used in the Fall experiment. A second brochure was designed to present comfort improvements as the core selling proposition. (Recall that the telephone survey of thirty Energy Bank's customers had revealed that the desire to increase comfort was cited as the second most important reason for buying home energy audits.) The second brochure, like the first one, contained the MFS

improvements as the core selling proposition. (Recall that the telephone survey of thirty Energy Bank's customers had revealed that the desire to increase comfort was cited as the second most important reason for buying home energy audits.) The second brochure, like the first one, contained the MFS endorsement and communicated The Energy Bank's technical expertise in the field of energy conservation.

As discussed in the next section, the Fall experiment showed that direct mail in the target market (Newton) was as cost-effective as personal selling, so a direct mail approach was used in the Spring experiment. The use of direct mail also removed interviewer effects from the presentations that were being compared. The sample sizes that were used are large enough to detect a 1/2 percent difference in response rates, when the expected response to each brochure is around 1 percent.

Research Results and Their Marketing Implications

The Fall study was designed to verify the hypothesized definition of the target market and to test the cost effectiveness of two media alternatives--direct mail and personal selling. Audit sales generated by the two approaches are displayed in Table 3. As shown, the actual sample sizes are somewhat different from the planned values. Only in the case of personal selling in Melrose is the actual sample size significantly lower than the planned value. Cost and time considerations prevented further efforts at contacting additional respondents in Melrose.

INSERT TABLE 3

Verification of the Target Market Definition

As hypothesized, the audit sales-to-contacts ratio for energy audits--for both direct mail (to MFS members and non-members) and personal selling--

was higher in Newton than in Melrose. Direct mailings to MFS members were almost twice as effective in Newton (4.8 percent response rate) as they were in Melrose (2.5 percent response rate). Direct mailings to Melrose residents who were not members of MFS failed to generate a single audit sale. On the other hand, the response rate from mailings to 710 non-members in Newton was 1.5 percent. For personal selling, proportionately twice as many audit sales were generated in Newton as in Melrose.

These response rates, and the conclusions that are drawn, are susceptible to sampling error. A commonplace method that is used to estimate this uncertainty is to construct confidence intervals for the response rates.

Assume that the generation of audit sales in each cell in Table 3 is a binomial random variable where the sample size, n, represents the number of Bernoulli trials and the probability of "success," Π, is given by the response rate. Following the Central Limit Theorem, the binomial distribution, $B(r; \Pi, n)$ can be approximated by the normal distribution, $N(r; n\Pi, \sqrt{n\Pi(1-\Pi)})$ when $n\Pi > 5$. When $n\Pi$ is five or less, the normal distribution is no longer a good approximation of the binomial distribution. Anderson and Burnstein (1967 and 1968) present procedures for approximating the upper and lower bounds for binomial confidence intervals.

The 95 percent confidence intervals for the six response rates are displayed in parentheses in Table 4. The implications of these confidence intervals can be illustrated by considering the cell that displays the response rate and corresponding confidence interval for direct mailings to non-MFS members in Newton. The implication is that if the Fall study were to be repeated twenty times, under identical conditions, in nineteen of these repetitions the observed response rates would fall between 0.9 percent and 2.8 percent.

INSERT TABLE 4

In comparing response rates in Newton to those in Melrose, one test is to see if the confidence intervals in Table 4 overlap. This comparison reveals that the confidence intervals for direct mailings to non-members do not overlap, whereas in the other two cases they do. The statistical implications of this observation, as argued in Appendix A, are that for direct mailings to non-members, the null hypothesis of equal response rates between Newton and Melrose can be rejected at 95 percent confidence level (and possibly at more stringent levels). In situations where the standard errors of the sample means are not known (and cannot be estimated), the presentation in Appendix A is useful for testing the hypothesis that the true means are equal.

It is, however, a stringent test and leads to Type II errors in that hypotheses that are rejectable at 95 percent confidence level are not rejected. The common solution for large samples is to assume that the variables can be approximated by a normal distribution. For two of the cases in Table 3 this would be inappropriate, since the audit sales are five or less. In such cases, the use of the standard normal Z-test is suspect.

Binomially distributed variables, however, permit the use of Fisher's exact test when the number of "successes" is five or less. This test calculates the exact probability associated with a given set of observations and all other more extreme sets. If the cumulative probability of these sets is less than the significance level of the test, the null hypothesis is rejected.

Test results for comparing the response rates in Newton and Melrose are given in Table 5. As mentioned earlier, direct mail to non-MFS members in Newton did yield a higher response than similar mailings in Melrose; the

difference is statistically significant at 95 percent (and probably even higher) confidence level. In the other two cases--direct mail to MFS members and personal sales effort--the difference is not significant at 95 percent; but the probability values, both for the Z-test and for Fisher's exact test, are low.

INSERT TABLE 5

In an attempt to generate additional audit sales, follow-up calls were made to some of the MFS homeowners randomly selected from those who had been sent a brochure through the mail. These calls were made two weeks after the mailings. A total of eighteen calls to MFS members in Melrose were made, but no audit sales were generated. In Newton, however, four sales were generated in response to twenty follow-up calls. This favorable response and the response to the direct mailings themselves provide considerable support for the hypothesis that economic well-being is indeed relevant to the definition of the target market for energy conservation services. In fact, a second, larger phone compaign (114 calls) to MFS members in Newton, conducted two months after the initial mailing, generated eight new audit sales. It is clear that phone follow-up of these mailings yield additional audit sales (in areas which fit the target market description) and thus, increase the profitability of the overall campaign.

Cost-Effectiveness of Media Alternatives

The Fall study was also designed to provide information on the cost-effectiveness of direct mail versus personal selling as a marketing medium.

Table 4 displays confidence intervals that permit comparison of response rates of the two media alternatives. The results of this comparison, and those from the z-test and Fisher's exact test, are shown in Table 5. Both media alternatives generated higher numbers of audit sales among MFS members than did mailings to non-members. This finding is true for Melrose and Newton, and is statistically significant at more than a 95 percent confidence level. As indicated by the p-values for Newton in Table 5, the personal selling response rate was considerably better than the direct mail response rate for MFS members. This finding is significant at a 90 percent confidence level. In Melrose, however, the personal selling approach did not generate proportionately as many sales when compared with the sales generated by direct mailings to MFS members.

However, what do these differences in response rates imply about the cost-effectiveness of each medium? The simplest measure of cost-effectiveness is the cost per audit sale. Actual costs will, of course, vary from organization to organization. The participation of MFS, a non-profit organization, lowered absolute costs from those likely in other situations.

Costs associated with the personal selling approach were found to be five times the variable costs of a single-piece mailing. For The Energy Bank analysis that follows, variable costs of mailing each brochure amounted to $0.50, and those of arranging a sales presentation of 5 minutes amounted to $2.50. Included in the mailing costs are the following cost elements: copy and graphics (20¢), printing (5¢), cover letter copy and printing (8¢), envelope (1¢), bulk mailing (8¢), stuffing (2¢) and miscellaneous (6¢). The cost of arranging a sales presentation comprised direct labor ($6.00 per hour with 5 sales calls per hour), direct supervision ($1/call based on a $400 weekly salary), brochure (25¢), and miscellaneous

(5¢). See McLeod and Miller (1979) for detailed break-downs of these cost figures.

Table 6 displays costs per audit sale for mailing brochures to MFS members and non-members, and for a personal selling approach. Direct mailing to MFS members is the most cost-effective way to generate sales among the three approaches. Where non-members (in Newton) are concerned, despite the fact that personal selling generates a higher response rate than direct mail, when the higher cost of sales personnel is taken into consideration, it cannot be determined that either approach is more cost-effective than the other.

INSERT TABLE 6

Response to Alternate Messages

The Spring study was designed to evaluate two core selling propositions for marketing energy conservation services. Two alternative communication appeals were considered: (1) cost savings, and (2) improvement in comfort. The response rates for these messages are displayed in Table 7.

INSERT TABLE 7

The sales response to the cost savings appeal was higher than the response to the comfort improvement message, but (from Table 5) the difference is not statistically significant. This is not entirely surprising since

these were the two most frequently mentioned factors in the telephone survey that led to the construction of the customer profile. Both brochures also included an endorsement of The Energy Bank by MFS. Perhaps the equality of response to the two brochures simply indicates that homeowners are well aware of the cost savings and comfort improvements that energy conservation improvements yield, but are reluctant to invest a large sum of money (about $1700) without some assurance of the technical expertise and reliability of the vendor.

Summary

Energy experts have indicated that strong conservation measures will be an essential part of any successful effort to meet the energy demands of the next decade. The residential conservation industry, however, has not demonstrated its ability to "sell" the energy conservation message to homeowners as effectively as will be needed.

This paper examines the use of a direct response marketing strategy in selling residential energy conservation services. The direct response approach was used because it combined some advantages of personal selling techniques with those of mass communication marketing. A direct response program allows the delivery of a tailored message to a defined audience at a cost that is substantially below personal selling techniques. The audit sales generated from the direct response program could then be addressed using more intensive marketing techniques.

This paper investigated the merits of this proposition through a case study of The Energy Bank, a full service energy firm in the Boston area. The first part of the study developed a customer profile through a telephone survey of previous energy audit customers. The results of this survey led to

a hypothesis on the target market definition: The Energy Bank's typical customer is economically well-to-do, living in a single-family home that was built more than twenty years ago.

The Fall study (the second part of the overall research) confirmed that upscale economic status is relevant to the target market definition of The Energy Bank's services. The upper-middle income community of Newton yielded higher response rates for both direct mail and personal selling approaches than the response rates for Melrose, a lower-middle income community.

The Fall study compared the response rate and cost-effectiveness of the direct mail and personal selling approaches to each other. While personal selling to the homeowners (non-MFS members) in Newton yielded a higher response rate than that realized for direct mail (7.7 percent vs. 1.5 percent), their cost-effectiveness was approximately equal ($32.5 vs. $33.3 per audit sale).

Mailings to MFS members yielded promising results both for The Energy Bank and MFS. The response rate in Newton was 4.8 percent and the differences in cost-effectiveness with the direct mail campaign to non-members ($10.4 vs. $33.3) and with the personal selling approach ($10.4 vs. $32.5) were statistically significant, at least at the 95 percent confidence level. Endorsement of The Energy Bank's service by MFS was important in communicating trust, especially to MFS members--a quality that is sorely missing in the energy conservation business. The results suggest that The Energy Bank should solicit the cooperation of special-interest groups like the Rotary Club and the Optimist Group in reaching out to the member constituents of these organizations.

The Spring study was designed to find a suitable core selling proposition for the marketing of energy conservation services. In the initial telephone survey of past buyers, two reasons were generally cited for their

purchase of The Energy Bank's retrofit service: (1) cost savings, and (2) improvement in comfort. The cost savings message did yield a higher response rate, but the difference was not significant at a 95 percent confidence level. According to experts in the energy conservation area, however, the economic appeal is more effective in stimulating consumer interest in residential energy conservation services. ("The chance to save money is the most effective incentive in inducing a consumer to conserve energy" (Milstein 1976, p. 9).)

While some of these results are not applicable in all situations, the overall approach and general findings may serve to stimulate other more innovative and more effective marketing programs. In light of the anticipated energy shortage, advances at every level will be needed and should be encouraged.[4]

Appendix A

Hypothesis Testing Through Confidence-Interval Comparison

In testing the null hypothesis that the means of two independing normal populations - $N_1(\mu_1, \sigma_1^2)$ and $N_2(\mu_2,\sigma_2^2)$ - are equal, a commonly used procedure is to obtain two samples of size, n_1 and n_2, and compare the sample means $\bar{x}_1$ and $\bar{x}_2$. The null hypothesis that $\mu_1 = \mu_2$ is then rejected at the 95 percent confidence level if

$$\frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \geq 1.96 \quad , \tag{A1}$$

or,

$$|\bar{x}_1 - \bar{x}_2| - 1.96\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} > 0 \quad . \tag{A1}$$

For convenience, assume $\bar{x}_1 > \bar{x}_2$. Then, the requirement that the 95 percent confidence intervals do not overlap is expressed as

$$\bar{x}_1 - 1.96\sqrt{\frac{\sigma_1^2}{n_1}} - \left(\bar{x}_2 + 1.96\sqrt{\frac{\sigma_2^2}{n_2}}\right) > 0 \quad ,$$

or,

$$\bar{x}_1 - \bar{x}_2 - 1.96\left(\sqrt{\frac{\sigma_1^2}{n_1}} + \sqrt{\frac{\sigma_2^2}{n_2}}\right) > 0. \tag{A2}$$

Now if $\frac{\sigma_1^2}{n_1} >> \frac{\sigma_2^2}{n_2}$ or $\frac{\sigma_2^2}{n_2} >> \frac{\sigma_1^2}{n_1}$, equation (A2) is approximately the same as equation (A1). But as $\frac{\sigma_1^2}{n_1}$ and $\frac{\sigma_2^2}{n_2}$ are more nearly equal, equation (A2) becomes a stronger test of the null hypothesis that $\mu_1 = \mu_2$.

The importance of this discussion is that it holds for any probability distribution. If the 95 percent confidence intervals for two independent variables do not overlap, then the null hypothesis that their true means are equal can be rejected with at least 95 percent confidence. In situations where all that is known about the variables is their confidence intervals, the above relationship forms a useful hypothesis-testing procedure.

Footnotes

1 A poll conducted during August, 1979 by the Decision Research Corporation of Waltham for a local Boston television station (WBZ-TV) found that only 50% of the greater Bostonians polled believe that there is an energy shortage.

2 Comparisons with the general population are difficult since aggregate data is unavailable or seriously dated. The 1970 Population Census is the most recent source for most items. To make comparisons possible, the following adjustments were used on the 1970 information:

(1) property values were inflated 100 percent, which is the residential fixed investment deflator for the period 1970-78; and

(2) family income estimates were inflated 65 percent, the value of the GNP price deflator for the period 1970-78.

3 Required sample size, N, is given by $Z = \frac{P_1 - P_2}{\sqrt{\frac{P_1(1-P_1) + P_2(1-P_2)}{N}}}$

where P_1 = 0.5 percent and P_2 = 1.5 percent as hypothesized and Z = 1.96 for a 95 percent confidence level if the distribution is normal.

4 As a postscript, it is worth mentioning that The Energy Bank and Massachusetts Fair Share have considerably expanded their joint efforts in marketing energy conservation services through direct response approach. A recently completed mailing campaign to 20,000 households which fit the target market definition has so far yielded a response rate of slightly over 1%. The Energy Bank's monthly sales are up 300 to 400% from last year.

Table 1

SELECTED FINDINGS ON THE CUSTOMER PROFILE

	Audit Only (n=10)	Retrofit (n=17)	Total (n=27)
Current Market Value:			
Less than $50,000	40%	6%	19%
$50-75,000	30	36	33
$75-100,000	30	24	26
More than $100,000	--	36	22
Household Income:			
Less than $20,000	40%	18%	26%
$20-50,000	60	53	56
More than $50,000	--	29	18
College Education	50%	88%	74%
Years Lived in Home	4.6	8.8	7.3
Average Age of Home (Years)	93	111.5	107
Year Home Built:			
1971-1978	--	6%	4%
1961-1970	20%	6	11
1951-1960	--	6	4
1941-1950	10	6	7
Before 1940	70	76	74

Table 2

FALL EXPERIMENT DESIGN

SALES-MEDIUM	MARKET: Lower-Middle Income (Melrose)	MARKET: Upper-Middle Income (Newton)
DIRECT MAIL		
• MFS Members	250	250
• Non-Members	750	750
PERSONAL SELLING		
• Non-members	250	250

SPRING EXPERIMENTAL DESIGN

	COST SAVING MESSAGE	COMFORT MESSAGE
DIRECT MAIL ONLY	2000	2000

Table 3

NUMBER AND PERCENTAGE OF AUDIT SALES
FROM THE FALL STUDY

	Melrose	Newton
DIRECT MAIL		
• MFS Members	7/275 = 2.5%	17/354 = 4.8%
• Non-Members	0/971 = 0 %	11/710 = 1.5%
PERSONAL SELLING		
• Non-Members	5/125 = 4.0%	19/246 = 7.7%

Table 4

CONFIDENCE INTERVALS ON THE RESPONSE RATES
FROM THE FALL STUDY

	Melrose	Newton
DIRECT MAIL		
• MFS Memebers	2.5 (1.2-5.2)	4.8 (3.0-7.6)
• Non-Members	0 (0-0.4)	1.5 (0.9-2.8)
PERSONAL SELLING		
• Non-Members	4.0 (1.3-9.1)	7.7 (5.0-11.8)

Table 5

SUMMARY RESULTS OF HYPOTHESIS TESTING OF DIFFERENCE IN AUDIT SALES RATES

	Non-Overlapping Confidence Intervals	p-Value z-Test	p-Value Fisher's Exact Test
Area Comparison (Newton vs. Melrose)			
Direct Mail-MFS	NO	.0643	.1048
Direct Mail-Non MFS	YES*		
Personal Selling	NO	.0643	.1247
Media Comparison			
Newton			
Direct Mail-MFS vs. Direct Mail-Non MFS	YES*	.0040*	.0024*
Direct Mail-MFS vs. Personal Selling	NO	.0764	.0970
Direct Mail-Non MFS vs. Personal Selling	YES*		
Melrose			
Direct Mail-MFS vs. Direct Mail-Non MFS	YES*		
Direct Mail-MFS vs. Personal Selling	NO	.2327	.3147
Direct Mail-Non MFS vs. Personal Selling	YES*		
Copytesting			
Cost vs. Comfort	NO	.2148	.3020

Table 6

VARIABLE COST PER AUDIT SALES FOR THE FALL STUDY

	Melrose	Newton
Direct Mail		
MFS Members	$20.0	$10.4
	(9.6 - 41.7)	(6.6 - 16.7)
Non-Members	∞	$33.3
	(125 - ∞)	(17.9 - 55.6)
Personal Selling		
Non-Members	$62.5	$32.5
	(27.5 - 192.3)	(21.2 - 50.0)

Table 7

RESPONSE RATES AND ASSOCIATED CONFIDENCE INTERVALS
OF ALTERNATE COMMUNICATION APPEALS

	Cost Savings	Comfort
No. of Audit Sales/Sample Size	16/2032	12/2053
Response Rate	.8%	.6%
(95% Confidence Interval)	(.46 - 1.3)	(.28 - 1.1)

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JUL 3 0 1999

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MAR 0 8 1957

DEC 1 3 2001

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737932 D*BKS 00131718
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Stoker, Thomas/Statistical aggregation
739540 D*BKS 00135684
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Von Hippel, Er/Appropriability of inno
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